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ABSTRACT

A set of interactive computer exercises developed for undergraduate students in experimental psychology and statistics courses is described. Each exercise is part of a self-contained module composed of an on-line experiment, full supporting documentation introducing the student to a substantive area of psychology, data analysis, a quiz with accompanying solutions, and references for extended research. The primary purpose of the exercises is to introduce students to the basic methodological principles of behavioral research and to allow students to explore substantive areas of research by actively participating in user-friendly computer-run experiments. The quizzes at the end of each module illustrate some of the fundamental principles of experimental psychology by giving the students practice in identifying independent and dependent variables, discriminating within-subject and between-group experimental designs, and identifying possible sources of confounding variables. The set of programs includes on-line experiments, statistical analyses, and simulation of statistical processes. The real-time experiments include classic behavioral experiments such as reaction time and pattern recognition. In addition, two of the computer activities explore recent advances in human performance and personality research. (IS)

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# Interactive Computer Exercises for Undergraduates in the Behavioral Sciences

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## INTRODUCTION

A set of interactive computer exercises has been developed at the University of California, Santa Barbara for undergraduate students in experimental psychology and statistics courses. Each exercise is part of a self-contained "module" composed of an on-line experiment, full supporting documentation introducing the student to a substantive area of psychology, data analyses, a quiz with accompanying solutions, and references for extended research. These materials are the result of a project to incorporate computer activities into the experimental psychology course taught at the University of California, Santa Barbara.

The primary purpose of the behavioral science "software library" is to introduce students to the basic methodological principles of behavioral research and to allow students to explore substantive areas of research by actively participating in user-friendly computer-run experiments. The quizzes at the end of module documentation illustrate some of the fundamental principles of experimental psychology by giving the students practice in identifying independent and dependent variables, discriminating within-subject and between-group experimental designs, and identifying possible sources of confounding variables. The set of programs includes on-line experiments, statistical analyses, and simulation of statistical processes. The real-time experiments include classic behavioral designs such as reaction time and pattern recognition. In addition, two of the computer activities explore recent advances in human performance and personality research.

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**SAMPLE ACTIVITY I : PERSONALITY AND COGNITIVE PROCESSES**

A recent development in personality theory is utilized in a computer program that conducts an experiment designed to examine the nature of self-reference and the encoding of personal information (Rogers, Kuiper, & Kirker, 1977). The experimental design implemented in this computer activity combines elements from personality theory and cognitive psychology by investigating the degree to which the self is implicated in processing personal information.

In this particular computer-run experiment, students are required to rate words presented one at a time on the computer screen on the basis of their structural characteristics (e.g. Is this word less than 5 characters in length?), their acoustic characteristics (e.g. Does the word rhyme with ...?), their semantic characteristics (e.g. Does the word mean the same as ...?), or their self-referential characteristics (e.g. Does the word describe you?).

After rating all of the words, the student is asked without warning to recall as many of the rated words as possible. The principles of "levels of encoding theory" are demonstrated by performance differences in the structural, acoustic, semantic, and self-referential encoding conditions. According to the levels of encoding theory (Craik and Tulving, 1974), the structural, phonemic, and semantic encoding conditions lie on a continuum from shallow to deep that produces progressively better encoding and, consequently, better future recall. In addition, the documentation explains that the superior recall typically observed in the self-referential rating task condition is taken by personality theorists as evidence that information about the self is treated somewhat differently than other information processed in human memory.

This "Cognition and Personality" module includes (as most other modules do) a quiz on the conceptual and methodological issues in experimental psychology raised by the computer activity. for example, in the quiz provided in this module primacy and recency effects in recall tasks are discussed. In the quiz students are also asked to think about the possible effect on the probability of recall due to answering "yes" versus "no" to a particular rating. The concept of analysis of covariance and mathematical data transformations are briefly introduced in the solutions to these questions as well as the issue, central to experimental psychology, of alternative interpretations.

**SAMPLE ACTIVITY II : ADVANCE INFORMATION AND REACTION-TIME PERFORMANCE**

Another computer-run experiment in the behavioral science software library involves an application of the "movement precuing technique" recently introduced by Rosenbaum (1980). The movement precuing technique is designed to reveal the major information processing steps that lead up to the execution of voluntary movements. The technique is based on a visual choice reaction time procedure in which the subject is supplied with partial advance information about certain defining characteristics of an upcoming motor response (e.g. right hand) that must be executed when the reaction signal is presented. In this experiment there are four possible responses (index finger or middle finger keypress with the right or left hand); students make responses by pressing keys on the computer keyboard as rapidly as possible after the presentation of the reaction signal. Subjects are presented with a "precue signal" some period of time before the signal to respond (50, 100, 150, 200, or 500 msec before the reaction signal). The precue provides the subject with information about a defining characteristic of the response that will be required when the reaction signal is presented.

The precue signals employed in this particular experiment indicate which finger (index or middle) and/or which hand (right or left) will be required in the movement specified by the upcoming response signal. The advance information provided by the precue signal allows subjects to improve their performance by reducing their reaction time in the task. The discussion of the experiment in the accompanying documentation explains how the obtained pattern of reaction times for the different precue conditions allows investigators to increase their understanding of the information processing operations that lead to the execution of voluntary movements.

**SIMULATING BINOMIAL PROCESSES IN A COIN-TOSSING EXPERIMENT**

A simulation has been developed to illustrate some basic principles of probability and sampling in the context of behavioral research by presenting students with data regarding the accuracy of a hypothetical subject who predicts whether a coin-toss will come up heads or tails. The hypothetical subject claims to be endowed with extra-sensory perception (ESP). The task for the student is to determine whether or not the statistical evidence indicates that the simulated subject really does have ESP. The student specifies the size and number of samples of the hypothetical subject's performance in the coin-toss

prediction task. By interactively "playing" with the simulation and observing the relationships between sample size, number of samples, data reflecting the hypothetical subject's performance, and the actual state of the world (i.e. whether or not the ESP person really does possess ESP or not), the student has the opportunity to learn about statistical concepts in a direct, tangible fashion.

**OTHER ACTIVITIES IN THE BEHAVIORAL SCIENCE SOFTWARE LIBRARY**

Additional programs have been developed to conduct experiments investigating visual search, stimulus-response compatibility, perceptual defense, psychological refractoriness, and lexical decision. Several of the experiments include a statistical analysis as well as a summary of the data generated by the student in the experiment in order to provide the student with immediate feedback regarding his/her performance in the task. The computer programs that run experiments with reaction time procedures also present a graphical summary of the students trial-by-trial performance so that any trends in the data can be easily ascertained.

All of the computer activities have been explicitly designed for undergraduates with little or no background in computing. Students interact with the program through a series of prompts and menus that allow them to receive on-line instructions, specify certain experimental parameters, participate as subjects in the computer-run experiment, and obtain graphical summaries and statistical analyses of their data. Each of the programs include documentation that provide an introduction to the area of research covered by the program along with a complete explanation of the experiment and the results. In addition, there is a quiz at the end of the documentation which tests the students on the major methodological and theoretical concepts covered in the experiment and documentation. A complete set of answers to all of the quizzes is provided for the instructor to facilitate immediate utilization of the computer activities in a classroom context.

The set of computer activities has been developed and successfully pilot-tested at the University of California, Santa Barbara with the support of an instructional development grant. The programs run on an Apple II microcomputer with 48K and a disk drive. All of the activities have been programmed in the BASIC programming language.

One advantage of these activities is that they can be completed in a single session that introduces the student to substantive concepts and issues through active participation and interaction with a computer program. Another advantage of these exercises is that they give students the opportunity to be both an experimental and a subject. In their role as experimenters, students are asked to select the number of trials, to specify certain parameters in some of the experiments, and to interpret their results, as well as to try to identify potential weaknesses in the experiments they are participating in. In their role as subjects, students experience some of the potential problems facing subjects (such as boredom, if the number of trials selected is too high), and attempt to guess the purpose of the experiment they are participating in. Taking again the role of experimenters, students then try to assess the impact of the aforementioned factors on the results generated during the experiment.

The entire set of computer programs and accompanying documentation are available to educators and interested individuals for the cost of materials (i.e. floppy disks and documentation) and can be obtained by writing to Marirosa Donisi, Psychology Dept., University of California, Santa Barbara, CA 93106 or Paul Reed, AT&T Bell Labs Room 1C-325B, Whippany Rd., Whippany, NJ 07981.